“Hydroxyapatite based Bio-compatible Composites for Adsorption Studies”.

A Synopsis Submitted
to
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Synopsis

Abstract of proposed work plan/ problem:

1. Introduction

Water is one of the most important substances on earth. All plants and animals must have water to survive. If there is no water there would be no life on earth. It is most important that the water which people drink and use for other purposes is clean water. This means that the water must be free from germs, hazardous dyes or drugs and chemicals and be clear. Heavy metals, dyes and pharmaceutical effluents because of their non-degradable, persistent and accumulative nature are toxic when present in trace amounts and source of environmental concern. Toxicity at trace levels leading to adverse health effect. A wide range of industries (mining, metal processing, electroplating) release heavy metals such as lead, cadmium etc. A wide range of pharmaceuticals companies and hospitals waste release pharmaceuticals effluents. The dyes also present in water due to different cloth companies. These presence in water is very hazardous for living things. So there is a need of purification of water for healthy life.

Adsorption is considered as effective, efficient and economic method for water purification. The performance of an adsorptive separation is directly dependent on the quality and cost effectiveness of the adsorbent. The last decades has seen continuous improvement in the development of effective noble adsorbents in the form of activated carbon, zeolites, hydroxyapatite, clay minerals, composites and functionalized polymers etc. Some researchers are making use of waste materials for this purpose. Still, there is a need to search new adsorbents.

Hydroxyapatite, also called hydroxyapatite (HA), is a naturally occurring mineral form of calcium apatite with the formula $Ca_5 (PO_4)_3(OH)$, but it is usually written $Ca_{10} (po_4)_8(OH)_2$ to

denote that the crystal unit cell comprises two entities. Hydroxyapatite is the hydroxyl end member of the complex apatite group. The OH^- ion can be replaced by fluoride, chloride or carbonate producing Fluorapatite or chlorapatite. It crystallizes in the hexagonal crystal system. Pure hydroxyapatite powder is white. Naturally occurring apatite's can, however, also have brown, yellow, or green colorations, comparable to the discolorations of dental fluorosis [1]. Up to 70% by volume and 70% by weight of human bone is modified form of hydroxyapatite, known as bone material. Hydroxyapatite is good sorbent which is used for waste water treatment and adsorption of unwanted and hazardous elements from water. Hence, the main aim of the proposed work is to develop biocompatible and eco friendly adsorbent based on hydroxyapatite.

2. Review of literature and development in the subject (previous work done in the relevant area)

Adsorption is one important technique in drugs/dyes/heavy metals removal from aqueous solutions. Numbers of groups are working on waste water treatment. The details are as follows:

International status:

Feng, Yuan et al has carried the Adsorption of Cd (II) and Zn (II) from aqueous solutions using magnetic hydroxyapatite nanoparticles as adsorbents [2]. El-Zahhar, Adel A., and Nasser S. Awwad et al has shown the removal of malachite green dye from aqueous solutions using organically modified hydroxyapatite [3]. Hou, Huijuan et al has carried out removal of Congo red dye from aqueous solution with hydroxyapatite/chitosan composite [4]. Ofudje E. A. et al has studied the synthesis and characterization of hydroxyapatite nanoparticles and its adsorption parameters for Zn (II) and reactive yellow 4 dye in aqueous solution [5]. Benedini, Luciano, et al has shown the Adsorption/desorption study of antibiotic and anti-inflammatory drugs onto bioactive hydroxyapatite nano-rods [6]. Li, Zhen, et al has studied the removal of tylosin and copper from aqueous solution by biochar stabilized nano-hydroxyapatite [7]. Kim, Jinsu, Nonni Soraya Sambudi and Kuk Cho et al have carried the removal of Sr2+ using high-surface-area hydroxyapatite synthesized by non-additive in-situ precipitation [8].) Ferri, Michele, Sebastiano Campisi, and Antonella Gervasini et al have shown that nickel and cobalt can be adsorbed on hydroxyapatite for the de-metalation of electronic industrial wastewaters [9]. Oulguidoum and Abdeladim et al has studied the development of sulfonate-functionalized hydroxyapatite nanoparticles for cadmium removal from aqueous solutions [10].

National status:

Narwade V.N., R. S. Khairnar, and Vanja Kokol et al has studied the in-situ synthesized hydroxyapatite-loaded films based on cellulose nanofibrils for phenol removal from wastewater [11]. Narwade et al has studied the in situ synthesized hydroxyapatite—cellulose nanofibrils as bio-sorbents for heavy metal ions removal [12]. Mondal, Poonam, and Suja George have studied the removal of fluoride from drinking water using novel adsorbent magnesia-hydroxyapatite.[13]. Yakub, Ismaiel, and Wole Soboyejo have showed the adsorption of fluoride from water using sintered clay-hydroxyapatite composites [14]. Ramesh, S. T et al has carried the adsorptive removal of Pb (II) from aqueous solution using nano-sized hydroxyapatite [15]. Gupta, Neha, Atul K. Kushwaha, and M. C. Chattopadhyaya has studied the adsorptive removal of Pb2+, Co2+ and Ni2+ by hydroxyapatite/chitosan composite from aqueous solution [16]. Prabhu, and Subbaiah Muthu has studied the synthesis and characterization of graphene oxide-doped nano-hydroxyapatite and its adsorption performance of toxic diazo dyes from aqueous solution [17]. Chand, Piar, and Yogesh B. Pakade have studied the synthesis and characterization of hydroxyapatite nanoparticles impregnated on apple pomace to enhance adsorption of Pb (II), Cd (II), and Ni (II) ions from aqueous solution [18]. Gogoi, and Diganta have shown that the studies on removal of cobalt from an alkaline waste using synthetic calcium hydroxyapatite [19]. Kousalya, G. N., M. Rajiv Gandhi, and S. Meenakshi have studied the removal of toxic Cr (VI) ions from aqueous solution using nano-hydroxyapatite-based chitin and chitosan hybrid composites [20].

3. Objective of the research

The main aim of proposed work is prepare low cost, non-toxic, composite adsorbents. In proposed work, composites will be prepared in which hydroxyapatite will be used as main matrix element and bio-waste or agriculture waste or suitable material will work as filler material. The research work will carried out for adsorption of heavy metals, dyes and pharmaceutical waste by using composite material. The objectives are as follows:

1) To procure /synthesize the adsorbent material namely hydroxyapatite via suitable method
2) To prepare the composite material by using bio waste/agricultural waste/suitable material as a filler material.
3) To characterize synthesized/procured material and composite materials by XRD, AFM, TGA/DTA, FTIR.

4) To carry out adsorption studies using composites.
5) To optimize various adsorption parameters namely concentration, time, pH etc.

4. Methodology

- The adsorbent material will be prepared or procured.
- The adsorbent material will be characterized by XRD, AFM, SEM, TGA/DTA characterization technique.
- The composite material will be prepared by using bio waste/agriculture waste/suitable material as filler material (with different proportions).
- The simulated solution of particular dyes/drugs/heavy metals will be prepared.
- The prepared composite material will be added in solution of dyes/drugs/heavy metals.
- The prepared solution will be kept on stirrer for constant stirring for particular time.
- The stirred solution will be filtered by filter paper.
- The concentration of particular dyes/drugs/heavy metals before and after adsorption, will be determined by using UV-visible spectrophotometer.
- Above procedure will be performed by varying time, concentration of the solution, contact time of adsorbent and pH of the solution.
- The adsorption parameters will be optimized.
- If possible, pharmaceutical waste, dye industry waste and industrial waste will collected and will be analyzed by following same procedure.

5. Importance of Study / Social applications:

Water pollution is a global problem. It is the outcome of urbanization, industrialization and population growth. Water is needed for all purposes. However, the water which people drink and use for other purposes should be clean i.e. water must be free from germs, hazardous dyes or drugs and chemicals and be clear. This reveals that water treatment is essential.

The proposed work will deal with the water treatment by adsorption process with the help of biocompatible composite adsorbents. The composites developed in this proposed work may lead to improvement in water quality and reduction in water pollution. Thus, the work may help in keeping environment clean and will indirectly helpful to the society.

Significance of Study:

The prepared composites will be biocompatible and eco-friendly. This composites used in various as industries for water purification.

6. Proposed work plan / formulation and structure of study:

It is proposed to make an intensive literature survey in the adsorption pertaining to hydroxyapatite composite. Hydroxyapatite based porous composites will be prepared wherein hydroxyapatite work as the main matrix element and agriculture or bio-waste or suitable material used as filler material. The prepared adsorbent material will be characterized by AFM, SEM and XRD for their surface topology at nano-scale, at micro-scale and structural determination respectively. The prepared composite material will be added in solution of dyes/drugs/heavy metals. After stirring, prepared solution will be filtered by using filtered paper. The prepared solution will be characterized by UV characterization before and after adsorption. This procedure will be performed by varying time, concentration of the solution, contact time of adsorbent and pH of the solution.

Year-wise plan:-

The following work will be carried out as per the time duration listed below**.**

First year:-Completion of pre-Ph.D course work, literature survey, synthesis or procured of samples, understanding the experimental method, to gain expertise in handling sophisticated instruments like XRD, TGA, UV-Vis and FTIR, understand the adsorption phenomenon.

Second year:- Characterization of synthesized samples, standardization process of composite preparation ,preliminary studies on adsorption , characterization by XRD, TGA, AFM, Uv-vis and FTIR etc for physical and chemical investigations, participation and presentation in international and national seminars/conferences/workshops/symposium, paper publication.

Third year:- Study the adsorption by varying time, concentration of the solution, contact time of adsorbent and pH of the solution, paper publications, participation and presentation in international and national seminars/conferences/workshops/symposium, thesis writing and submission.

7. References:

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